Wear and fracture of nanoscale multilayer PVD coatings for cutting tool

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Wear protective nanoscale coatings for metal cutting applications have advanced considerably in the last years. Some coatings can extend tool life by providing a protective layer that insulates the cutting edge from wear and fracture. But not all coatings can provide this protection.

In the field of PVD methods, the often used coatings are based on the ternary Ti–Si–N system, thinks to significantly better oxidation resistance compared to that of TiN, excellent thermal and mechanical properties. A composite coating such us TiSiAlN, TiSiCrN, TiSiZrN is used to increase the tool life of the cutting tool and productivity of machining. The objective of this study is to investigate the wear mechanism develops during turning of a coated tool on the medium carbon and stainless steel work pieces.

The substrates were cemented carbide inserts (WC–6% Co), which were prepared using cathodic arc evaporation process, resulting in a deposition temperature of ~ 550^{o}C. Typical thickness of films (TiN, TiSiN, TiSiAlN, TiSiCrN and TiSiZrN) rangers from 5 to 6 μm, thickness of multilayer (TiSiN – TiSiAlN, TiSiN – TiSiCrN, TiSiN – TiSiZrN) rangers from 30 to 50 nm. The chemical composition of the coatings was investigated by GDOES technique. XRD and SEM investigations were used for studying their phase composition, texture, microstructure and morfhology. The compressive residual stress analyzed using the XRD $\sin^2\psi$ method. The hardness, elastic modulus and elastic recovery were determined with a help of a nanohardness tester equipped with a Vickers indenter. Adhesion strength was measured by means of scratch tester. SEM investigations performed on fracture cross section indicated a fragile structure of coatings and plan-view scanning electron micrographs from the rake face of coating inserts after turning test.

The developed coated tools show the lowest maximum flank wear, but they exhibited lower nose wear and crater wear than tools coated with TiN and TiSiN shows tool life in the turning steels. The nanoscale multilayer coatings primarily increase wear resistance, but they may also reduce cutting forces and temperatures at the tool edge and thereby indirectly affect the deformation and fracture behavior of the tool.